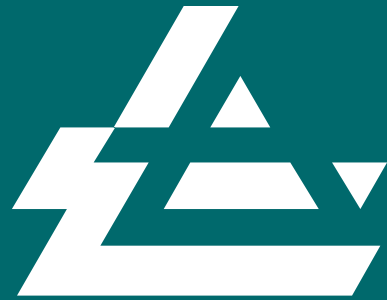


AIR
PRODUCTS



A photograph of four children of diverse backgrounds holding a small globe of the Earth. The image is overlaid with a semi-transparent blue filter. The children are smiling and looking at the globe. The globe is positioned in the center, held by the children's hands.

Hydrogen Infrastructure Fueling a Cleaner Future

Robert N. Miller
Air Products and Chemicals, Inc.
29 April 2003

Air Products' future energy solutions

Air Products is a \$6 billion global company that supplies 50% of the merchant hydrogen market



- Demonstration leader – 20 fueling stations
- Developing solutions for the H₂ economy – sourcing, on-site generation, storage
- Global safety leader
 - Codes & standards team
 - KnowH₂owSM safety training
- Founding member of the National H₂ Association

A Reliable Hydrogen Supply Infrastructure in Florida for over 35 years



Liquid Hydrogen Infrastructure

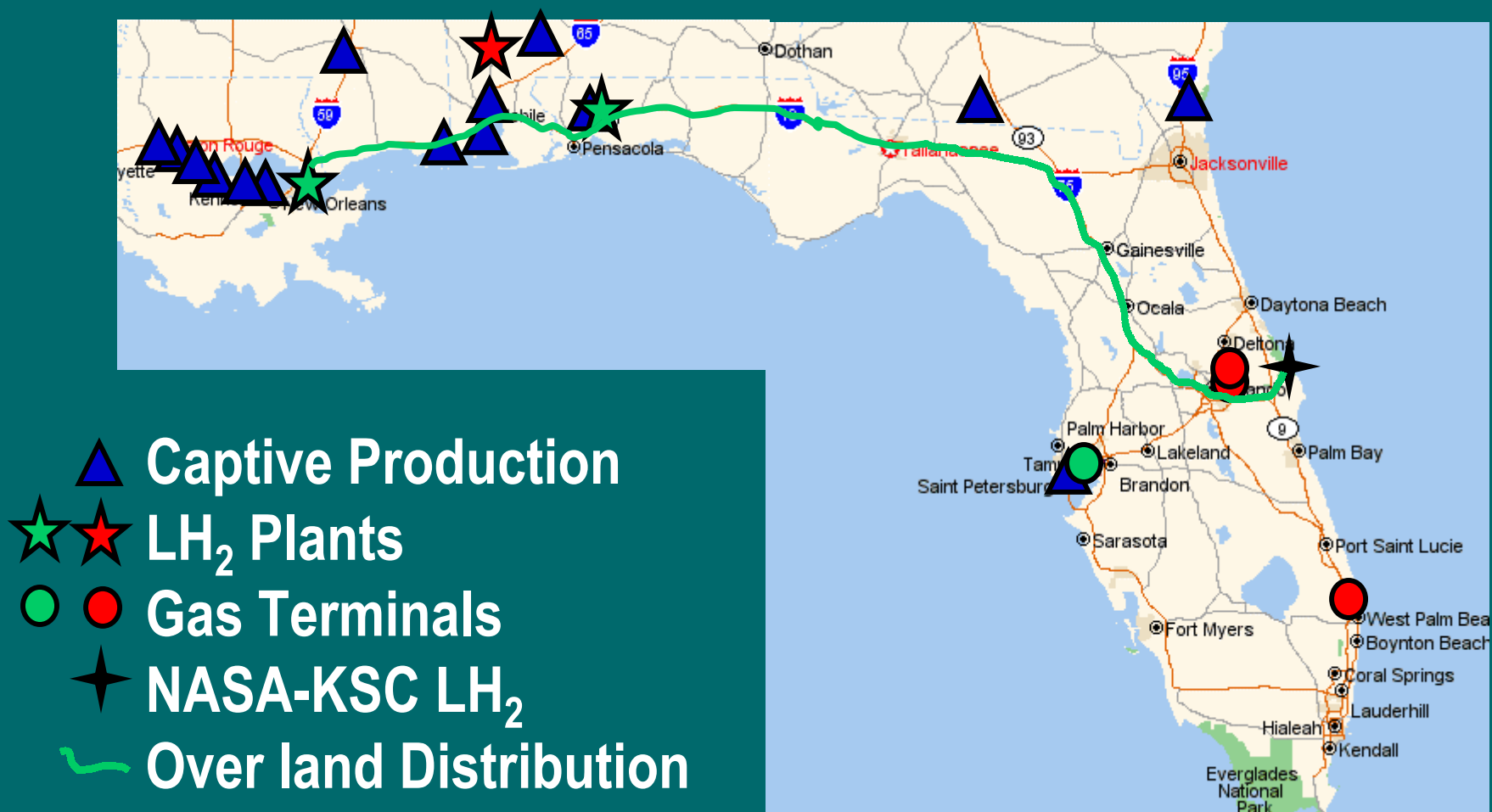
Air Products Southeast

- 2 Production Sites: 50% of North American Capacity

| Location | Feedstock | TPD | MMSCFD |
|---------------------|-------------|------------|-----------|
| New Orleans, LA (2) | Natural Gas | 74 | 28 |
| Pace, FL | Natural Gas | 32 | 12 |
| | | <u>106</u> | <u>40</u> |

- Delivery by tankers – Up to 3,300 kg (~6,500 vehicles)
- Up to 9 tankers per day (1 every 30 min. nationwide)
- Driven safely over 11,000,000 miles per year
- 106 TPD = 96K kg = 25,000 fills = 100,000 vehicles in service

Southeastern U.S. Hydrogen Infrastructure



Data Source : DOE NREL

Hydrogen fuel station experience

CaFCP,
Sacramento, CA



Chicago
Transit
Authority, IL



Ford,
Dearborn, MI



City of
Las Vegas, NV



Hydrogen Fuel Stations in the Early Years

- **Hydrogen Fuel Station**

- Sized for delivery of 2, 20, 200 or 2000 kg/day servicing 4, 40, 400 or 4000 vehicles.
- Consists of fuel source, compression, storage & dispenser.
- Hydrogen Generation by SMR or Electrolysis

- **Hydrogen Fueler**

- Self contained portable fueling center
- 150 kg capacity with $\geq 80\%$ utilization for fueling up to 200 vehicles in service
- Meets all codes & standards for transport, dispensing and storage of hydrogen fuel
- Complete refill and transport services

Hydrogen fueler

- Totally self-contained
- No site installation
- High reliability
- Zero emissions



Infrastructure overview

Today

Hydrocarbon sourced infrastructure exists

- Global production: 45 billion kg/yr
- Industrial applications: chemicals, metals, electronics, space
- 95% of H₂ used captively



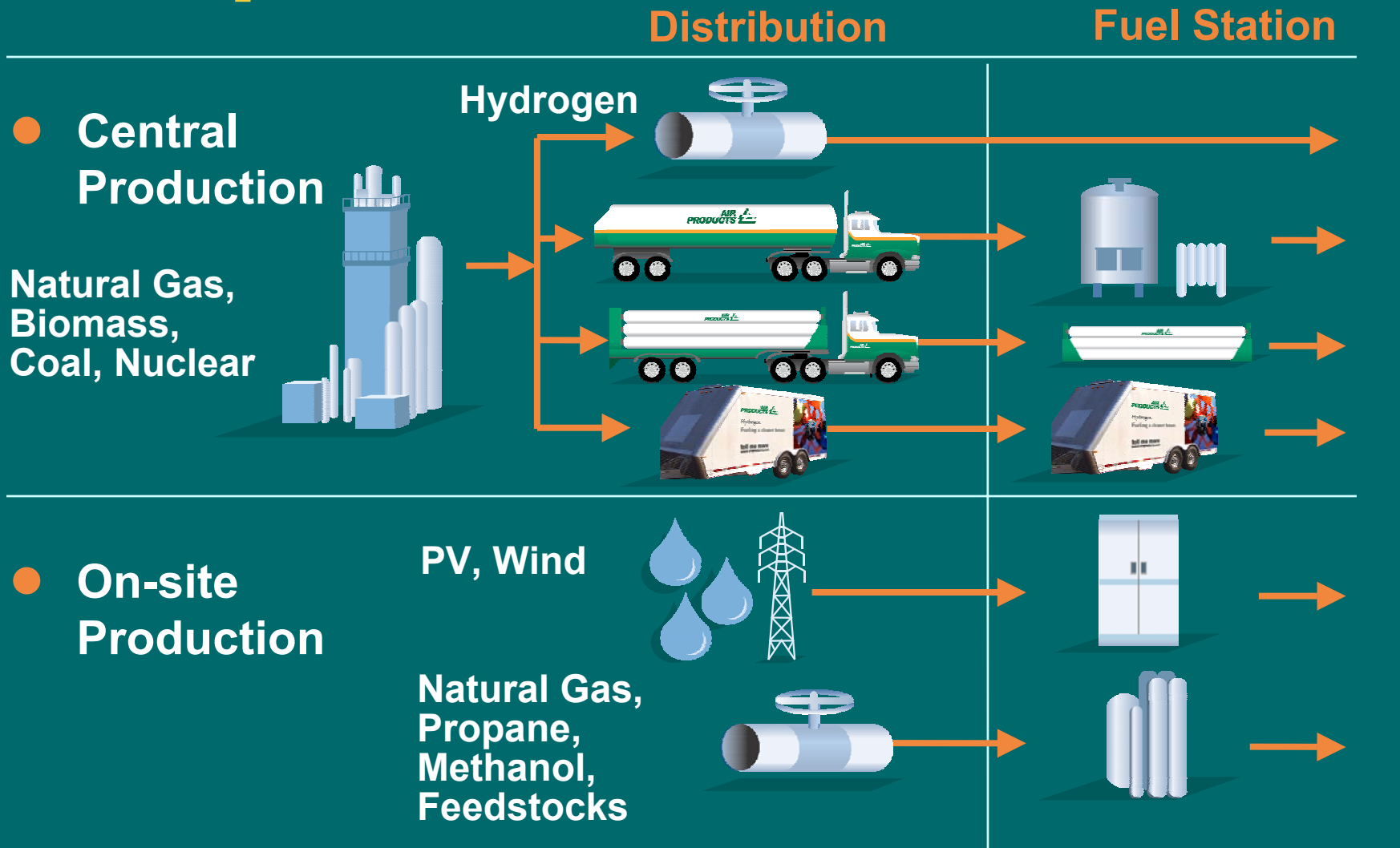
PATHWAY?

Tomorrow

Renewable sourced H₂ for transportation and energy storage for power generation



Hydrogen sourcing - transportation

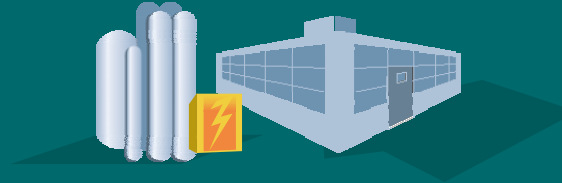


Hydrogen sourcing - power generation

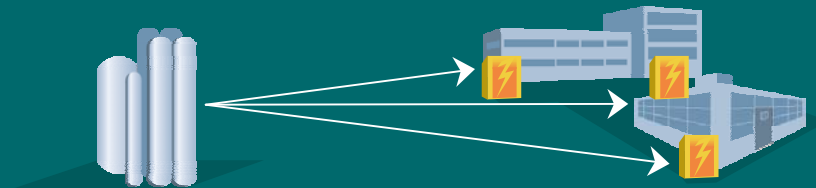
- Packaged delivery



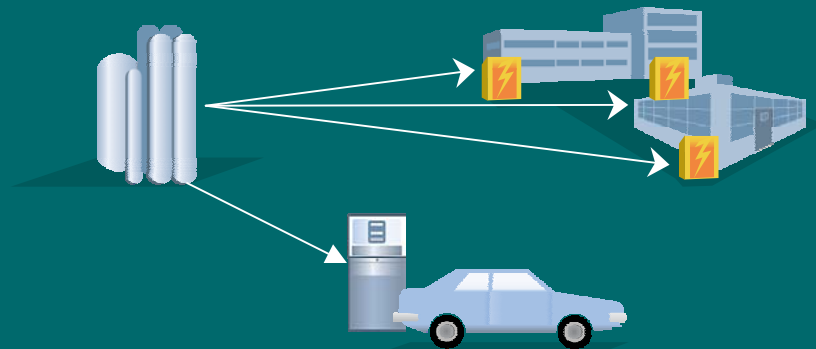
- On-site production integrated reformer



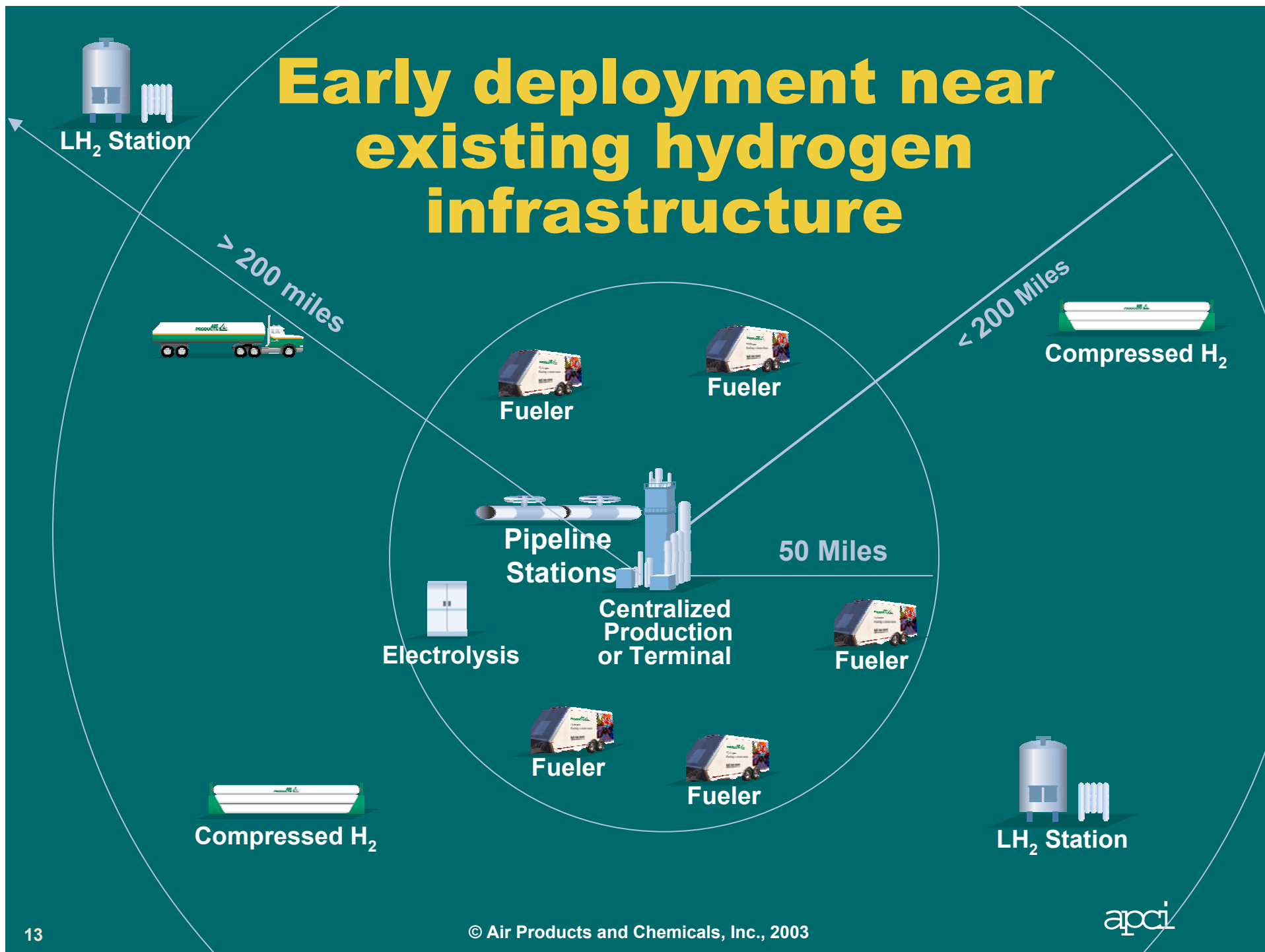
- Power park



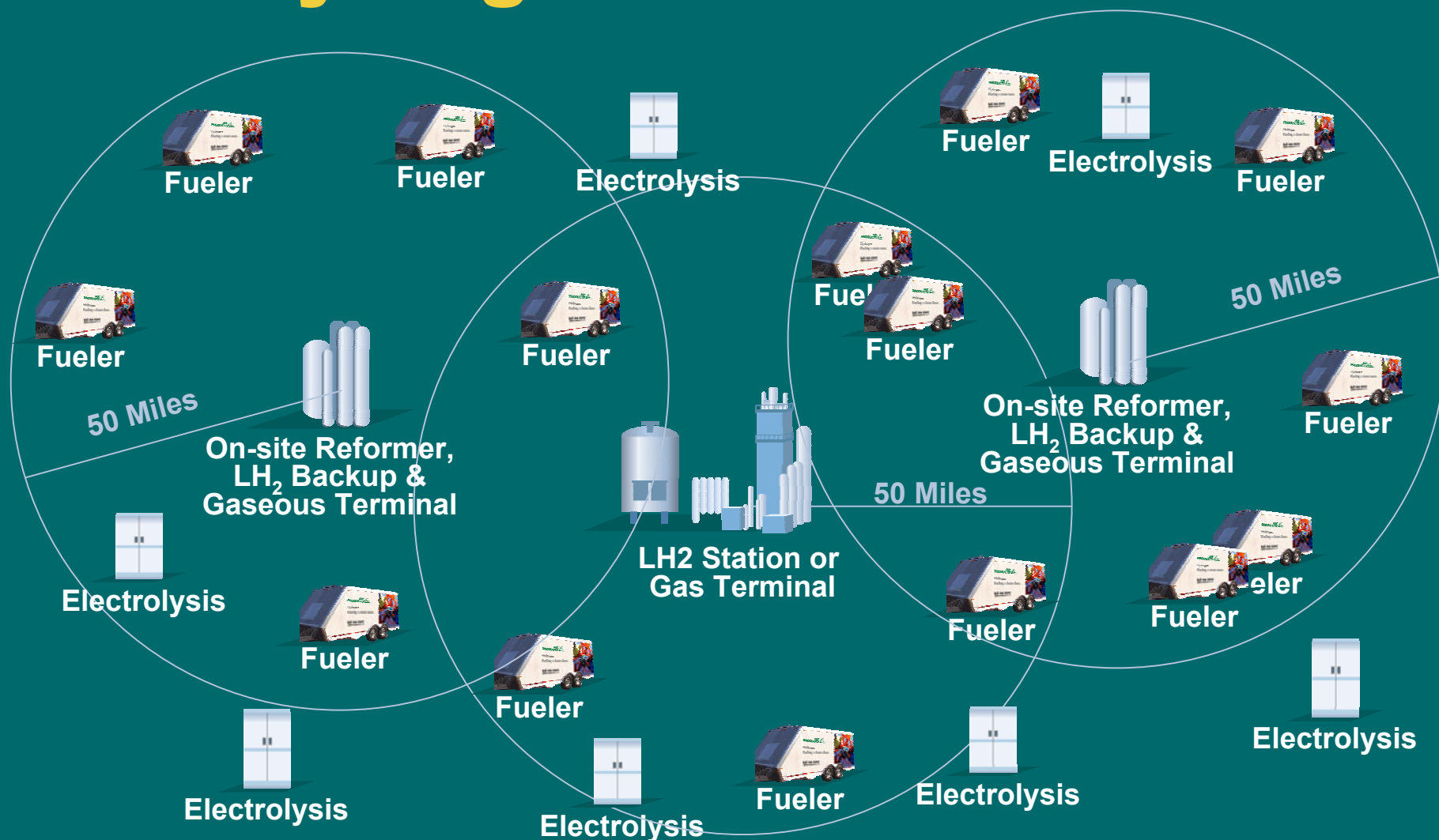
- Energy station



Early deployment near existing hydrogen infrastructure



Deployment beyond existing hydrogen infrastructure



Requirements for infrastructure success

- Need to develop vehicles and fuel together
 - Capital utilization critical for payback
- Must achieve competitive system cost early
(both fuel and fuel cell)
- High reliability fueling essential for fleets and backup/critical power generation
- On-site generation/fueling with off-site/fast fill capability
 - Off-site availability for market penetration of fleet vehicles and to build start of retail infrastructure
- Easy, low-cost expansion beyond demonstrations

Summary

- Hydrogen is available now
- There will not be a single pathway solution
 - Based on application needs and locations
- Long-term, lowest-cost solution still being developed
 - Depends on the ultimate fuel cell, vehicle and device needs

Thank you

tell me more

www.airproducts.com/H2energy